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# Why do young children die in the UK? A comparison with Sweden

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## ABSTRACT

**Background** The UK has a high child mortality rate, whereas Sweden's is lower (under-five mortality rates of five and three, respectively, in 2011).We therefore wished to compare causes of death in young children aged <5 years in the two countries.

**Methods** Under-five mortality data were obtained from the Office of National Statistics for each of the individual countries within the UK for 3 years (2006–2008). Data for Sweden for the same period were obtained from the National Board of Health and Welfare. Causes of death were compared statistically using $\chi^2$ test.

**Results** There were a total of 14 104 and 1036 deaths aged <5 years in the UK and Sweden, respectively, between 2006 and 2008. The total numbers of live births during the same period were 2 295 964 and 315 884, respectively. The overall mortality rate in the UK was 614 per 100 000 children which was significantly higher than that in Sweden (328; p<0.001). The mortality rates for the three main causes of death in the UK (prematurity, congenital malformations and infections) were 138.5, 112.1 and 63.9, respectively, per 100 000 children. The mortality rates for the same three conditions in Sweden were 10.1, 88.6 and 34.8, respectively. They were all significantly more frequent in the UK than in Sweden (p<0.001), as were the majority of the disorders. Treatable infections, such as pneumonia, meningitis and septicaemia, in both neonates and young children had significantly higher mortality rates in the UK than in Sweden (p<0.001).

**Conclusions** In order to reduce the mortality rate in the UK, we need to try and reduce the causes of prematurity. Additionally, the care of children with treatable infections should be reviewed to understand ways in which to reduce the differences in mortality seen.

### What is already known

- The UK has a high child mortality rate, whereas Sweden has a low child mortality rate.
- Prematurity is the major cause of death in children aged <5 years.
- Socioeconomic inequalities contribute to child mortality and prematurity.

### What this study adds

- The mortality rates for infections in children aged <5 years were significantly higher in the UK than in Sweden.
- The majority of these infections are treatable.
- Research should focus on service delivery and access rather than new medicines.

## INTRODUCTION

Child mortality rates (neonatal, infant and under five) in the UK are higher than in many other European countries.[1] The under-five mortality rate (U5MR) is considered by Unicef to be one of the best indicators of the health of the children within any given country.[1] It is determined from the number of deaths per annum in relation to every thousand live births. High rates of preterm births are thought to be a major contributory factor to the high mortality rates in the UK.[2] It is not, however, the only factor.

We decided to compare mortality rates in the UK with another European country to identify differences in mortality rates for different diseases. We chose Sweden, as it has one of the lowest child mortality rates in Europe (U5MR of three in 2011).[1] Both the UK and Sweden have free public healthcare systems and similar levels of economic and social development. They both spend about 8% of their GDP on healthcare.[1] Neonatal intensive care and interventions in Sweden are similar to the UK.[3] In Sweden and the UK, all neonatal deaths are recorded, irrespective of weight or gestation.[3]

In order to reduce the high child mortality rate in the UK, we need to understand the reasons why children die. We therefore decided to look at the causes of deaths in both countries. We were particularly interested in causes where treatments are available and especially those diseases where we currently have effective medicines.

## METHODS

Under-five mortality cause-specific data were obtained for England and Wales,[4] Scotland[5] and Northern Ireland[4–6] (UK) and Sweden[7] for the available years 2006–2008.

Data for cause-specific U5MRs according to the ICD-10 classification and annual number of live births for England and Wales were obtained from the Office of National Statistics. Data for Scotland were obtained from the General Register Office for Scotland and the data for Northern Ireland were obtained from the Northern Ireland Statistics and Research Agency. Additional information was obtained for the four countries in the UK by contacting the individual offices holding the data.

Data for Sweden were obtained from The National Board of Health and Welfare.[7]

There are two major limitations to the use of the ICD classification. First, a large proportion of child

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**Table 1** Mortality rates in UK and Sweden: 2006-2008, ICD classification

| ICD code | Disease | Mortality rates per 100 000 population | | | | | |
|---|---|---|---|---|---|---|---|
| | | 0–27 days | | 28 days–4 years | | Total under 5 | |
| | | UK | Sweden | UK | Sweden | UK | Sweden |
| P0–96 | Certain conditions originating in the perinatal period | 296.9 | 97.2 | 27.8 | 10.4 | 324.6 | 107.6 |
| Q0–99 | Congenital malformations and chromosomal anomalies | 68.6 | 50.0 | 43.7 | 38.7 | 112.1 | 88.6 |
| R0–99 | Symptoms, signs, abnormal clinical and laboratory findings not elsewhere classified | 7.8 | 21.0 | 33.8 | 23.4 | 41.5 | 44.3 |
| G0–99 | Diseases of the nervous system | 4.0 | 2.5 | 21.2 | 11.7 | 25.1 | 14.2 |
| V0–Y89 | External causes of morbidity and mortality | 3.7 | 1.3 | 15.5 | 12.1 | 19.2 | 13.3 |
| A0–B99 | Certain infectious and parasitic diseases | 0.4 | 3.5 | 18.1 | 7.9 | 18.4 | 11.4 |
| J0–J99 | Diseases of the respiratory system | 0.1 | 0.3 | 17.9 | 8.2 | 17.9 | 8.5 |
| C0–D48 | Neoplasms | 0.8 | 1.6 | 13.8 | 15.5 | 14.5 | 17.1 |
| I0–99 | Diseases of the circulatory system | 2.7 | 1.3 | 11.7 | 2.8 | 14.4 | 4.1 |
| E0–90 | Endocrine, nutritional and metabolic diseases | 4.1 | 1.9 | 9.2 | 10.4 | 13.3 | 12.3 |
| K0–93 | Diseases of the digestive system | 0.7 | 0.9 | 7.1 | 2.5 | 7.8 | 3.5 |
| D50–89 | Diseases of the blood and blood forming organs and immune system | 0.4 | 0.3 | 2.9 | 0.3 | 3.3 | 0.6 |
| N0–90 | Diseases of the genitourinary system | 0 | 0 | 1.1 | 0.3 | 1.1 | 0.3 |
| M0–99 | Diseases of the musculoskeletal system and connective tissue disorders | 0 | 0 | 0.7 | 0.9 | 0.7 | 0.9 |
| L0–99 | Diseases of the skin and subcutaneous tissue | 0.1 | 0 | 0.1 | 0.3 | 0.2 | 0.3 |
| H0–95 | Diseases of the eye, ear and adnexa | 0 | 0 | 0.2 | 0.3 | 0.2 | 0.3 |
| F0–99 | Mental and behavioural disorders | 0 | 0 | 0.1 | 0.3 | 0.1 | 0.3 |
| | Total | 390.2 | 181.7 | 224.9 | 146.5 | 614.3 | 328.0 |

deaths are classified under codes R0–99 (symptoms, signs, abnormal clinical and laboratory findings not elsewhere classified). This is not clinically helpful. Second, the majority of infections are classified under systems, for example, respiratory infections are classified under respiratory disorders and osteomyelitis is classified under disorders of the musculoskeletal system.

From the ICD classification a more clinically useful underlying cause of death was therefore allocated. Such an approach has been used by others.[8] In the cases of congenital malformations and chromosomal anomalies (Q0–99), neoplasms (C0–D48), diseases of the blood and blood-forming organs and immune system (D50–89), this was identical to the ICD classification. All infections were identified and grouped together (see online supplementary table S1). Conditions originating in the perinatal period (P0–96) were divided into (i) disorders related to prematurity, (ii) complications during labour and delivery, (iii) respiratory distress syndrome, (iv) other neonatal respiratory conditions, (v) neonatal haemorrhage and (vi) necrotising enterocolitis. Symptoms, signs, abnormal clinical and laboratory findings not elsewhere classified (R0–99) were evaluated and reassigned to the most appropriate clinical cause of death. Within external causes of morbidity and mortality (V0-Y89), trauma was separated. Conditions with a low mortality rate: genitourinary (N0–90), musculoskeletal (M0–99), skin (L0–99), eye and ear (H0–95) and mental and behavioural (F0–99) were combined into the miscellaneous group along with any conditions that were not classified.

The cause-specific mortality deaths were grouped similarly for UK and Sweden. Data were combined for 3 years for analysis. $\chi^2$ test was used to compare the number of deaths between the two countries. Mortality rates (per 100 000 population) were calculated to allow comparison between the two countries.

## RESULTS

There were a total of 14 104 and 1036 deaths aged <5 years in the UK and Sweden, respectively, between 2006 and 2008. The total numbers of live births in UK and Sweden during the same period were 2 295 964 and 315 884. The majority of the deaths occurred in the neonatal period, both in the UK (8960 (63%)) and Sweden (574 (55%)). There were 5144 deaths in the UK and 462 deaths in Sweden for children aged between 28 days and 4 years. The mortality rates for neonates, children aged 28 days to 4 years and children aged <5 years were all significantly higher in the UK than in Sweden ($p<0.001$; table 1)

Table 1 shows cause-specific mortality data for neonatal and postneonatal age groups according to the ICD-10 classification for 3 years. The limitations of the ICD code are illustrated by the fact that the third most common cause of death in both countries using the ICD code was symptoms, signs, abnormal clinical and laboratory findings not classified elsewhere.

Mortality rates in both countries and mortality rate ratios are given in table 2, using the clinical-based classification. The mortality rates for the majority of the causes of death were significantly more frequent in the UK than in Sweden (table 2). The mortality rate ratios ranged from 13.71 for prematurity to 1.27 for congenital malformations. SIDS, trauma, neoplasms, metabolic disorders, unclassified and miscellaneous deaths and deaths associated with pregnancy and labour were not significantly different between the two countries. There were no causes of death that were significantly more frequent in Sweden than in the UK. The three most common causes of death in the UK were prematurity, congenital malformations and infections with mortality rates ranging from 138.5 to 63.9 per 100 000. In contrast, the three main causes of death in Sweden were congenital malformations, disorders of pregnancy and labour and infections, with mortality rates ranging from 88.6 to 34.8 per 100 000.

Infections were the third most common cause of death in both countries. The causes of deaths due to infections are illustrated in table 3. Treatable infections in both the neonatal period and beyond were significantly more frequent in the UK ($p<0.001$). Specifically in the neonatal period, both neonatal sepsis ($p<0.001$) and congenital pneumonia ($p=0.001$) resulted

**Table 2** Mortality rates in UK and Sweden: 2006–2008

| Disease | Mortality rates per 100 000 UK | Sweden | Rate ratio | p Value |
|---|---|---|---|---|
| *Prematurity* | 138.5 | 10.1 | 13.71 | **<0.001** |
| Paediatric respiratory disorders | 5.9 | 0.9 | 6.56 | **<0.001** |
| Haematological and immunological disorders | 3.3 | 0.6 | 5.50 | 0.01 |
| *Neonatal respiratory disorders* | 34.2 | 8.9 | 3.84 | **<0.001** |
| Cardiovascular disorders | 28.1 | 9.2 | 3.05 | **<0.001** |
| *Necrotising enterocolitis* | 16.2 | 5.4 | 3.00 | **<0.001** |
| External causes of mortality | 4.3 | 1.6 | 2.69 | 0.02 |
| *Other neonatal disorders* | 18.6 | 7.3 | 2.55 | **<0.001** |
| Gastrointestinal disorders | 7.6 | 3.2 | 2.38 | **0.005** |
| *Respiratory distress syndrome* | 10.1 | 5.4 | 1.87 | **0.01** |
| *Neonatal haemorrhage* | 21.7 | 11.7 | 1.85 | **<0.001** |
| Infections | 63.9 | 34.8 | 1.84 | **<0.001** |
| Non-infectious CNS disorders | 19.7 | 12.0 | 1.64 | **0.003** |
| Trauma | 14.9 | 11.7 | 1.27 | 0.2 |
| *Congenital malformations* | 112.1 | 88.6 | 1.27 | **<0.001** |
| Metabolic disorders | 14.9 | 13.0 | 1.15 | 0.4 |
| *Pregnancy and labour problems* | 41.0 | 39.9 | 1.03 | 0.8 |
| SIDS | 26.7 | 26.0 | 1.03 | 0.8 |
| Unclassified and miscellaneous disorders | 18.0 | 20.6 | 0.87 | 0.3 |
| Neoplasm | 14.5 | 17.1 | 0.85 | 0.3 |
| Overall mortality | 614.3 | 328.0 | 1.87 | **<0.001** |

Italic entries represent neonatal disorders.
CNS, central nervous system.

in significantly more deaths in the UK than in Sweden. The mortality rate ratios were 2.39 and 7.5, respectively. In young children, respiratory infections (p=0.008), septicaemia (p<0.05) and meningitis (p<0.001) all resulted in significantly more deaths in the UK than in Sweden, with mortality rate ratios of 1.59–1.96.

## DISCUSSION

This brief review of child mortality in the two countries looked at different causes of death. Mortality rates were significantly higher for most diseases in the UK. This included diseases of the newborn and young children. Prematurity, congenital malformations and all neonatal diseases had significantly higher mortality rates in the UK. Similarly, most diseases in children had significantly higher mortality rates in the UK.

**Table 3** Mortality rates due to infections

| | Mortality rates per 100 000 UK | Sweden | Rate ratio | p Value |
|---|---|---|---|---|
| Neonatal infections (0–27 days) | | | | |
| Neonatal sepsis | 18.9 | 7.9 | 2.39 | **<0.001** |
| Congenital pneumonia | 4.5 | 0.6 | 7.50 | **0.001** |
| Congenital viral infections | 1.6 | 0.6 | 2.67 | 0.2 |
| Other neonatal infections | 3.0 | 3.2 | 0.94 | 0.8 |
| All neonatal infections | 27.9 | 12.3 | 2.27 | **<0.001** |
| Paediatric infections (28 days–4 years) | | | | |
| Respiratory infections | 11.2 | 6.0 | 1.87 | **<0.01** |
| Septicaemia | 10.5 | 6.6 | 1.59 | **<0.05** |
| Meningitis | 4.9 | 2.5 | 1.96 | **<0.001** |
| Viral infections | 6.6 | 5.1 | 1.29 | 0.3 |
| Other paediatric infections | 2.8 | 2.2 | 1.27 | 0.5 |
| All paediatric infections | 36.0 | 22.5 | 1.60 | **<0.001** |
| Total | 63.9 | 34.8 | 1.84 | **<0.001** |

One of the limitations is that the classification of death involves subjective decision making. It is therefore highly likely that there are small inaccuracies in the classification of deaths between the two countries that have different histories and cultures. The difficulties in classifying deaths and comparing mortality rates, especially in neonates have been described.[9] It is possible that some neonatal deaths were coded under prematurity in the UK rather than under other neonatal conditions. Such miscoding would increase the mortality rate ratio for prematurity but conversely decrease the mortality rate ratios for other neonatal diseases.

Prematurity is recognised as a major cause of mortality in young children. Socioeconomic factors and socioeconomic inequalities have a major influence on premature birth.[10 11] Socioeconomic inequalities as represented by the GINI index are greater in the UK than in Sweden.[12] The preterm birth rate is higher in the UK than in Sweden.[13 14] It has also been increasing in the UK, whereas in Sweden it has remained constant.[13 14] The contribution of preterm births to the high infant mortality rate in the UK has been highlighted recently by both researchers and the Royal College of Paediatrics and Child Health.[2 15] The high mortality rate from prematurity in the UK is not a reflection on the quality of neonatal intensive care. It is, however, a reflection on the adverse social determinants of health in the UK that result in a large number of preterm births.

Congenital malformations were the second most common cause of mortality in both countries. The mortality rate in the UK was, however, significantly higher than in Sweden. Studies in the UK have shown that socioeconomic inequalities result in significantly lower termination rates, following antenatal diagnosis of a congenital anomaly, in more deprived areas.[16] Socioeconomic inequalities are a significantly greater problem in the UK than in Sweden, and are therefore likely to be a major cause for the significantly greater number of deaths in the UK for both prematurity and congenital malformations.

Infections were the third most common cause of death in both countries. The mortality rates from infections in the UK were almost twice those in Sweden. In the majority of cases, the infections were conditions for which we have a variety of medicines which are effective. Both the UK and Sweden have free public healthcare systems and it is of concern that within the UK a significantly higher number of young children do not receive timely treatment for life-threatening infections. Concern regarding suboptimal treatment of meningococcal disease has been previously raised in the UK.[17]

The differences in mortality rates for a wide variety of clinical conditions including respiratory disorders in both young children and neonates, cardiovascular, gastrointestinal and neurological disorders raise important questions about the organisation and delivery of services for young children in the UK. Higher rates of hospitalisation for south Asian children with asthma in the UK have been reported.[18] It has been suggested that this is due to difficulties in accessing primary healthcare. The lack of training in paediatrics for all general practitioners (GPs) in the UK has been highlighted and contrasts with Sweden where all GPs have paediatric training.[2]

The majority of research funding within the UK is focused on clinical trials of new technologies and in particular different medicines.[19–21] Our findings suggest that it would be more

appropriate to fund research into service delivery to examine reasons why children do not receive existing treatment in a timely manner, rather than evaluating new medicines. The former is more likely to result in a significant reduction in mortality than the latter.

There are major differences in child mortality between the two countries. Action is needed to reduce the socioeconomic inequalities in the UK.[22] Additionally, one needs to learn from practices in Sweden with regards to the delivery of healthcare to families with young children.

**Competing interests** None declared.

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## REFERENCES

1 The State of the World's Children. *Children with disabilities*. New York, USA: UNICEF, 2013.
2 Wolfe I, Macfarlane A, Donkin A, *et al*. *Why young children die: death in infants, children and young people in the UK Part A*. Report from Royal College of Paediatrics and Child Health and National Children's Bureau. 2014.
3 Serenuis F, Källén K, Blennow M, *et al*. Neurodevelopmental outcome in extremely preterm infants at 2.5 years after active perinatal care in Sweden. *JAMA* 2013;309:1810–20.
4 Office for National Statistics. *Child mortality statistics: Childhood, infant and perinatal*. http://www.ons.gov.uk/ons/rel/vsob1/child-mortality-statistics–childhood–infant-and-perinatal/index.html
5 National Records of Scotland. *Vital Events Reference Tables*. http://www.nrscotland.gov.uk/statistics-and-data/statistics/statistics-by-theme/vital-events/vital-events-reference-tables
6 Northern Ireland Statistics and Research Agency. *Ireland North and South: A Statistical Profile* (2008). http://www.nisra.gov.uk/publications/default.asp18.htm
7 The National Board of Health and Welfare (Socialstyrelsen). (http://www.socialstyrelsen.se) (http://192.137.163.49/sdb/dor/val.aspx)
8 Pearson GA, Ward-Platt M, Kelly D. How children die: classifying child deaths. *Arch Dis Child* 2011;96:922–6.
9 *Neonatal and perinatal mortality: country, regional and global estimates*. World Health Organization, 2006.
10 Smith LK, Draper ES, Manktelow BN, *et al*. Socioeconomic inequalities in very preterm birth rates. *Arch Dis Child Fetal Neonatal Ed* 2007:92:F11–14.
11 Smith LK, Manktelow BN, Draper ES, *et al*. Nature of socioeconomic inequalities in neonatal mortality: population based study. *BMJ* 2010:341:c6654.
12 OECD. Growing Unequal? Income distribution and poverty in OECD countries.
13 Blencowe H, Cousens S, Oestergaard M, *et al*. National, regional, and worldwide estimates of preterm birth rates in the year 2010 with time trends since 1990 for selected countries: a systematic analysis and implications. *Lancet* 2012;379:2162–72.
14 World Health Organization. *The partnership for Maternal Newborn and Child Health*. Born Too Soon: The global action report on preterm birth. 2012.
15 Viner R, Hargreaves D, Coffey C, *et al*. Deaths in young people aged 0–24 years in the UK compared with EU15+ countries, 1970–2008: analysis of the WHO Mortality Database. *Lancet* 2014;384:880–92.
16 Smith LK, Budd LS, Field DJ, *et al*. Socioeconomic inequalities in outcome of pregnancy and neonatal mortality associated with congenital anomalies: population based study. *BMJ* 2011;323:d4306.
17 Ninis N, Phillips C, Bailey L, *et al*. The role of healthcare delivery in the outcome of meningococcal disease in children: case-control study of fatal and non-fatal cases. *BMJ* 2005;330:1475–8.
18 Netuveli G, Hurwitz B, Levy M. Ethnic variations in UK asthma frequency, morbidity, and health-service use: a systematic review and meta-analysis. *Lancet* 2005;365:312–17.
19 Choonara I. Paediatric research environment in the UK. *Paediatr Child Health* 2014;24:370–3.
20 National Institute of Health Research. *Annual report 2012/2013*.
21 Choonara I, Kenny T. Setting the research agenda for women and children: the role of Health Technology Assessment. *Arch Dis Child* 2013;98:574–5.
22 Wolfe I, Donkin A, Marmot M, *et al*. UK child survival in a European context: recommendations for a national Countdown Collaboration. *Arch Dis Child* Published Online First: 8 May 2015 doi:10.1136/archdischild-2014-306752.

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## Notes